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Comparative Assessment of the Proximate Contents of Poultry Feeds Formulated from Fruit Waste, Restaurant Left-over and a Commercial Feed Product

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Abstract

The sustainable management of waste is a pressing issue in today's world, and the agricultural sector is no exception; with many fruits being in deteriorated conditions before getting to the market. Further, many left-over foods from domestic and restaurant sources can be harnessed to meet the SDG need of zero-hunger. The purpose of this research was to produce pelletized poultry feeds from fruit wastes (coded A), left-over foods from selected restaurants in Abuja (coded B), and a composite of A and B (coded C) and to compare the proximate contents with a commercial poultry feed produced in Plateau State (VF). The proximate analysis of the VF feeds conducted in 2024 using standard methods indicated that the contents are: moisture 7.33±0.002%, fat 6.67±0.001%, ash content 13.72±0.004%, crude protein 18.82±0.001% and crude fiber 6.49±0.005%. However, crude protein follows the ranking A (30.13±0.0495) > C (21.70±0.0354) > A (10.27±0.0849) in the alternative feeds, indicating that B and C have protein above the specification of 16.50% in poultry feed. Fat was also higher in B and C than VF and above the recommended minimum of 5.00% in feed. Fibre and ash content were lower in the alternative feeds than VF and the specifications for feed. There was significant difference between protein, fat and ash contents of B and C compared to VF. Therefore, fruit waste, though rich in fiber is deficient in protein and fat. On the other hand, restaurant leftovers and the mix with fruit waste provide folds of protein and fat and smaller ash content (an indicator of mineral content). So, for sustainable poultry practice commercial poultry feed remains the most reliable option due to the standardization of the required nutrients for animal balanced diet and sustained national food security.

Keywords: Zero-hunger, proximate, alternative feeds, poultry feed

Introduction

Food waste refers to edible materials that are discarded or left unused at various stages of the food supply chain, including households, restaurants, and food processing units. The interest in alternative feed sources was borne out of the zeal to find alternative feeding materials for incorporation into animal diets particularly in developing countries where there has been an acute shortage of animal protein [1]. Globally, food waste constitutes a significant portion of waste, with an estimated 1.3 billion tonnes generated annually [2]. A considerable part of this waste contains nutrients suitable for poultry consumption.

In poultry production, feed costs account for approximately 60-70% of the total expenses [3]. Consequently, finding alternative low-cost feed sources such as food waste is imperative, especially for peasant poultry farmers. This stands as a potential to reduce production costs while addressing waste management challenges.

Food waste varies in its composition, typically containing carbohydrates, proteins, fats, vitamins, and minerals [4]. Depending on the source, it can potentially serve as a balanced diet for poultry. For example, food waste from bakery is rich in carbohydrates, while waste from restaurants and food processing may contain a mix of protein and fat. Several studies have highlighted that certain types of food waste, such as fruit and vegetable by-products, possess high moisture content and significant amounts of fiber, vitamins, and antioxidants [5]. However, proper processing is required to maintain nutrient density and prevent spoilage or contamination [6]. In contrast to traditional commercial feeds, which often rely on grains and other conventional ingredients, these waste-derived feeds present a promising opportunity to reduce waste, improve the profitability of poultry operations. However, the nutritional content of these alternative feeds must be rigorously assessed to ensure that they meet the dietary needs of poultry and do not adversely affect their health or productivity. and promote sustainability in poultry farming.

Jones & Smith [7] and the report of Wang et al. [8] highlighted the potential of using agricultural by-products and food waste respectively in animal feed formulations. However, comprehensive comparative studies specifically focusing on fruit waste and restaurant leftovers in poultry feeds remain limited. Since the objective of animal nutrition is to maximize the economic production performance. Uchegbu et al. [9] reported that diets are formulated to provide the specific level of nutrients that are needed for optimum performance. The main production criteria normally looked into are: feed conversion ratio, growth rate, health of the animal and their body conformation. The major determinants of these are the energy, protein and amino acids contents of the diets.

Therefore, in this research, three pelletized poultry feeds formulated from fruit waste (A), restaurant left-overs (B) and a blend of the duo (C) were analysed for the proximate contents and compared to that in a commercial poultry feed (VF). This is geared towards the sought for sustainable and cost-effective poultry feed alternatives. Among these alternatives, fruit waste and restaurant leftovers have garnered attention due to their nutritional potential and abundance.

A comparative assessment of the proximate contents (such as moisture, crude protein, crude fiber, fat, and ash) of poultry feeds formulated from fruit waste, restaurant leftovers, and commercial feed products is essential for understanding their nutritional value and potential as viable alternatives to traditional feed sources.

Materials and Methods

Sample collection and preparation

VF feed: The commercial feed samples were purchased from a major distributor of VF in Jos, Plateau State, Nigeria in 2024. The bags were kept in an aerated room on a wooden platform prior to the period of analyses.

Fruit waste: Further, fruit wastes (peel of water melon fruit, waste of sucked orange pulp and peel pine apple in 1:1:1) were periodically collected from selected fruit markets in Gwagwalada, Abuja in 2024 at close of market, into clean plastic containers (10 L capacity), and then transported to the laboratory.

Sorting and segregation of the composite samples of the fruit types were carried out into separate plastic containers, to give room for the ration as 1:1:1. Following which each fruit section was washed with clean tap water and subsequently with distilled water, to remove any surface contaminant.

Size reduction of the fresh waste was done by using a clean kitchen, making each to be reduced to 2-5 x 2 -5 x 2-5 cm^3. Each fruit type collected (5 kg) was separately dried using an industrial drier, and was removed when a constant weight was attained; aimed at preventing microbial growth. Each fruit type was separately ground using a mechanical feed mill grinder, into uniform particles of approximately 2-4 mm (around 5-10 mesh). The feed was formulated using 2 kg each of the ground fruit waste collected, mixing them in a mechanical feed mixer. Then 1:1:1 ratio of each group was added starch binder (50 ml/kg) and pelletized using a pelletizing machine, this was room-dried for 6 h and bagged, coded A.

Restaurant food left-over: The collection of food left-over (food waste) from pre-determined restaurants in Gwagwalada, Abuja was carried out in February 2024 into plastic containers. Separation between animal and non-animal waste was carried out manually. The composite food samples obtained was sorted and classified based on the nutritional profiles (carbohydrate-rich, protein-rich). The samples were shredded into uniform particle size of about 10 cm length, to aid in drying and mixing.

The sample of each nutritional profile was then dried gradually below 60^{o}C (to avoid nutrient loss, particularly heat-sensitive vitamins) with an industrial dryer and was removed when a constant weight was attained; aimed at preventing microbial growth. Each of the sample was separately ground using a mechanical feed mill grinder, into uniform particles of approximately 2-4 mm (around 5-10 mesh). The feed was formulated using 3 kg of the carbohydrate-rich sample to 1 kg of the protein-rich ground sample. These were then mixed in a mechanical feed mixer. To the mixture was then added starch binder (50 ml/kg) and then pelletized using a pelletizing machine, this was room-dried for 6 h and bagged, coded B. Sample C was obtained by mixing 60% of sample A to 40% of B, before binding and pelletizing was done. All samples were kept in an airtight container before chemical analysis.

Determination of proximate content of commercial feed and alternative feed sources

Moisture content [10]

To determine the moisture content, 5 g of the milled composite feed sample (VF), sample A, B or C was weighed into a clean oven dried pre-weighed (W_1) petri-dish. The dish with its content was transferred to the oven and heated to a constant weight at 105ºC for 3 hr. This was thereafter transferred to the desiccator, cooled and weighed (W_2). The moisture content (in percentage) was calculated as follows:

$$\%MC_{wb} = \frac{W_1 - W_2}{W_1} \times 100$$

Crude protein content [10]

The crude protein content of VF, A, B or C was separately determined using micro Kjeldahl method. To 1.0 g of the milled sample (VF, A, B or C) in a petri dish, 7.00 g of K_2SO_4 and 0.80 g of $CuSO_4$ were added and transferred to a crucible into a digestion tube. After addition of 12 cm^3 of H_2SO_4 (concentrated), the digestion tube was inserted into the digester and heated at 420ºC for 45 min. Digestion converts any nitrogen in the food (other than that which is in the form of nitrates or nitrites) into ammonia and other organic matter to CO_2 and H_2O. Ammonia gas was not liberated in an acid solution because the ammonia is in the form of the ammonium ion (NH_4^+) which binds to the sulphate ion (SO_4^{2-}) and thus remains in solution.

N(feed, A, B or C) → $(NH_4)_2SO_4$

Then the tube was removed and placed in tube rack. To the digested solution, 75 cm^3 of distilled water was added and allowed to stand for 5 min, then transferred to the distillation unit. A 25 cm^3 of 4 % boric acid was measured into a conical flask, to which the receiving tube was inserted, and placed at the receiving end of the distillation unit, then the safety door of the receiving end was closed.

To start the distillation, the alkali button was pressed so as to discharge NaOH and initiate steam generation. The reaction which takes place is as follows:

$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + 2H_2O + Na_2SO_4$

The mixture was steamed through, a process called distillation for about 5 -7 minutes to collect enough ammonium sulphate (about 25 cm^3). The sodium hydroxide converted the ammonium sulphate into ammonia gas which was liberated from the solution and moves out of the distillation flask to the receiving flask.

$2NH_3 + 2H_3BO_3 \rightarrow 2NH_4H_2BO_3$

The ammonium borate formed was titrated directly with 0.1 N HCl. The titre value T which is the volume of acid used was recorded. The same process was done for the blank except that the sample was substituted with 1 g of sucrose, and titrated against 0.1 M HCl (B=blank value).

The concentration of hydrogen ion (in moles) required to reach the end-point is equivalent to the concentration of nitrogen that was in the original feed. The nitrogen content of the sample was calculated using the formula:

$$\% \, Nitrogen = \frac{(T - B) \times 14.01 \times N}{Wieght \; of \; the \; Sample \times 10}$$

Percentage protein was calculated thus:

$\% \, Protein = \% \, Nitrogen \; \times$ $Conversion \; Factor$ (6.25)

Total ash content [10, 11]

A 5 g portion of the sample was weighed into a pre-dried and weighed (W_1) petri-dish and weighed (W_2), and heated in a furnace at 550°C until completely incinerated. This was thereafter transferred to a desiccator and allowed to cool, then weighed (W_3) and recorded. The total ash content was calculated thus:

$$\% \, Ash = \frac{W_3 - W_1}{W_2 - W_1} \times 10$$

Crude fat content [12]

A 5 g portion of the finely ground VF, A, B or C sample was placed in a cellulose thimble paper and fat extraction was carried out using hexane in a 250 mL Soxhlet extractor for 6 hours. The fat content was calculated as below:

$$\% \, Fat = \frac{W_2 - W_1}{W_3} \times 100$$

Where, W_1 = weight of empty flask; W_2 = fat extract + flask; W_3 = Weight of sample taken

Crude fiber content [10]

A 2.0 g of the defatted sample (W1) was taken into a 250 ml flat bottom quick-fit flask with 100 ml of the fiber reagent added to the sample in the flask. A reflux condenser was fixed to the flask and allowed in a heating mantle. The content was boiled in flask for 50 minutes by refluxing and shaking, often to ensure proper digestion of sample. The digested content was cooled and filtered. The residue was washed on the filter paper into a crucible (dish) with hot distilled H_2O. Then the content in the crucible was dried in an oven at 120°C-130^{0}C, and cooled in a desiccator, followed by the weight (W2). The crucible was then put in a muffle furnace at a temperature of 600^{0}C for six hours. This was removed, cooled and weighed (W3).

$$\% \, Crude \; fiber = \frac{W_2 - W_3}{W_1} \times 100$$

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) was used for all statistical analyses. Analysis of variance (ANOVA) was used to compare the means analytes. Significance was determined at $p<0.05$

Results and Discussions

The analytical results and discussion of the nutritional value of a poultry feed that are considered when proximate is mentioned are moisture, crude protein, ash content, crude fat, crude fiber.

Proximate contents of commercial feed and alternative feed sources

Moisture content has an effect on the physicochemical components the feeds, especially with respect to its stability and freshness when stored for a long time. It also affects the shelf life thereby influencing the presence of aflatoxins in feeds. Apart from the feed from fruit waste, all other samples have moisture content below the 11.00% minimum content specification for feed. The moisture content of Feed A in this study is however higher than that 10.0% reported for formulated feed from domestic waste by Johnson et al. [13].

Crude protein (CP) (%) of feed B (30.13±0.0495) and C (21.70±0.0354) were significantly higher than in the commercial feed, VF (18.815±0.1202) as presented in Table 1. Though all the studied samples have protein content above the minimum recommended level of 16.50% set by Standard Organization of Nigeria. The result in this study falls below the range of 30 – 40% CP reported in literature for feed produced from domestic waste and that of commercial broiler feed reported by Johnson et al. [13]. Generally, the restaurant left over food alone and a mix with the fruit waste served as highly nutritious source of crude protein than the commercial feed; aside the cost effectiveness.

Table 1: Proximate analysis of the VF Feed, Feed from Fruit Waste (A), Restaurant Food Waste (B) and C (Mixture of A and B)

Sample/ Parameter	C. Protein (%)	Fat (%)	Crude Fibre (%)	Moisture (%)	Ash (%)
A	10.27±0.0849	4.13±0.0354	8.22±0.0636	13.54±0.2404	4.15±0.0254
B	30.13±0.0495	30.16±0.0849	5.46±0.0141	7.86±0.1513	4.21±0.0436
C	21.70±0.0354	22.13±0.0636	5.76±0.2404	7.54±0.0636	4.33±0.0426
VF	18.815±0.1202	6.665±0.1344	6.495±0.0212	7.330±0.0566	13.718±0.1513
Specifications	**16.50 (min)**	**5.00 (max)**	**7.00 (max)**	**11.00 (max)**	**15.00 (Max)**

CP needed as amino-acid is necessary for development of feathers, growth of carcass and the production of egg [14]. The values obtained from the three alternative feeds in this study indicated that birds fed with these feeds will maximally get the inherent benefits from the alternative sources.

Ash content (AC) (%) is the amount of inorganic content that is present in the feed [15]. The analysis of the alternative feeds indicated that the ash content was in the range 4.15±0.0254 (A) to 4.33±0.0426 (C) for the alternative feed sources (below the 15.00% recommended limit); the value was 13.718±0.1513% in the commercial feed (VF); indicating significant elevation in the commercial feed. The highest value in the commercial feed could be as result of fortification of commercial feeds with additives like bone meal, blood meal among others.

The AC of VF feed has value below the range of values reported in related research carried out by Afolabi *et al* [16] whose value was 39%. Elevated ash content has been implicated in bone and associated joint problems, as well as crystal formation along the urinary tract. Therefore, VF has AC within the safe range.

Crude fat (CF) was highest in the feed from restaurant left-over waste (B) with value 30.16±0.0849 and least in the fruit waste sourced feed (A) with value 4.13±0.0354%. There was significant elevation of crude fat in feed B and C than in the commercial feed (VF) which recorded a value of 6.665±0.1344%; though within the recommended limit of 5.00% crude fat (ISO 6492:1999) set for poultry feed.

Fat soluble vitamins are easily adsorbed in poultry diet with the aid of crude fat. These values obtained in this study for the restaurant left-over sourced feed and the mix from it were all above the 5.0% (maximum fat level set for feed). So, the alternative feed sources can serve well for enhancing the fat needs of poultry, but needs to be used as fat supplement only; to avoid fat accumulation and subsequent diseases from such.

Crude fibre is needed for the digestibility of lower nutrients in monogastrics [17]. The fibre reported in Table 1 indicated that the fruit waste sourced feed (A) had the highest value of 8.22±0.0636%; while the feed B, C and the commercial feed (VF) had the crude fibre value in the range 5.46±0.0141 (B) to 6.495±0.0212 (VF).

Apart from feed A, the feeds had values within the permissible level of 7.0 % (ISO 6865:2000). There was a significant elevation of crude fibre in the feed from fruit waste ($p < 0.05$). Suggesting the incorporation of fruit waste up to 10% substituting maize and other ingredients in broiler chicken diet for enriching fibre in poultry feed production; without any adverse effect on the performance of the birds.

Conclusion

The need to maximize profit in poultry industry, especially in an era of high cost of raw materials used in producing feed, calls for alternative feed sources. The study reveals that the alternative feed sources can be beneficial in poultry production; B (feed from restaurant left-overs) and C (mix of feed from restaurant left-overs and fruit-waste-feed) had protein above the specification of 16.50% in poultry feed. Fat was also higher in B and C than VF (commercial poultry feed) and above the recommended minimum of 5.00% in feed. However, crude fibre and ash content were lower in the alternative feeds than VF and the specifications set for poultry feed.

References

1. Fasuyi, A. O. (2005). Nutritional evaluation of cassava (Manihot esculenta) leaf protein concentrate (CLPC) as alternative protein

source in rat assay. *Pakistan Journal of Nutrition*, 4, 50-56.

2. FAO (2013). Food Wastage Footprint: Impacts on Natural Resources. Food and Agriculture Organization.
3. Makkar, H. P. S. (2014). Utilization of food waste as feed. *Animal Feed Science and Technology*, 197, 1-11.
4. Salemdeeb, R. et al. (2017). Environmental and economic analysis of food waste as animal feed. Resources, Conservation and Recycling, 137, 45-57.
5. Kosseva, M. (2013). Processing of food wastes. Food industry wastes: Assessment and recuperation of commodities, pp. 135-159.
6. Arvanitoyannis, I. S., & Kassaveti, A. (2008). Food waste as a potential energy source. *Journal of Waste Management*, 28(2), 275-281.
7. Jones, D., & Smith, R. (2017). Utilizing food waste in livestock feed: A review. *Journal of Sustainable Agriculture, 10*(3), 155-167.
8. Wang, L., Zhang, M., & Ramaswamy, H. S. (2018). Nutritional and environmental impacts of food waste management. *Food and Bioproducts Processing*, 106, 35-48.
9. Uchegbu, M.C., Irechukwu, N.M., Omede, A.A., Nwaodu, C.H., Anyanwu, G.A., Okoli, I.C., and Udedibie, A.B.I. (2009). Comparative evaluation of three commercial feeds on the performance of broilers. Report and Opinion, http://www.sciencepub.net/report. In: Onyagbodor O.P. and Oyedeji, J.O. 2021. Quality assessment of some commercially produced animal feeds and two native forages in southern Nigeria. *The Zoologist*, 19, 23-29.
10. AOAC (2015). Official Methods of Analysis, 13th edition, Association of Official Analytical Chemists, Washington DC.
11. Thiex, N., Novotny, L., & Crawford, A. (2012). *Determination of Ash in Animal Feed: AOAC Official Method 942.05 Revisited. Journal of AOAC International, 95(5), 1392–1397.*
12. Mutayoba, S. K., Dierenfeld, E., Mercedes, V. A., Frances, Y., & Knight, C. D. (2011). Determination of chemical composition and anti-nutritive components for Tanzanian locally available poultry feed ingredients. *International Journal of Poultry Science*, 10(5), 350-357.
13. Johnson JT, Chibuike PO, & Ifeakor OD. (2022). Formulation and nutrient assessment of poultry feed from domestic waste and its effect on the growth of poultry birds. *International Journal of Agriculture Technology*, 2(1), 1-7.
14. Barszcz, M., Tuśnio, A., & Taciak, M. (2022). Poultry nutrition. *Physical Sciences Reviews*, 9, 611 - 650.

15. Bukar, H., and Saeed, M. D. (2014). Proximate analysis and concentration of some heavy metals in selected poultry feeds in Kano Metropolis, Nigeria. *Bayero Journal of Pure and Applied Sciences*, *7*(1), 75-79.

16. Afolabi, S.S., Oyeyode, J.O., Shafik, W., Sunusi, Z.A., and Adeyemi, A.A. (2021). Proximate Analysis of Poultry-Mix Formed Feed Using Maize Bran as a Base. *International Journal of Analytical Chemistry*, 2021:8894567. doi: 10.1155/2021/8894567*2021*.

17. Alshelmani, M. I., Loh, T. C., Foo, H. L., Sazili, A. Q., & Lau, W. H. (2016). Effect of feeding different levels of palm kernel cake fermented by *Paenibacillus polymyxa* ATCC 842 on nutrient digestibility, intestinal morphology, and gut microflora in broiler chickens. *Animal Feed Science and Technology*, *216*, 216-224.